

Title: Quantum Computing in Many-body Physics

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Abstract: When simulating many-body quantum systems, we usually experience an exponential explosion of computational complexity. Quantum computers allow us to overcome this problem in its basic principle. Thanks to R. Feynmann it is known that axioms of complexity theory depend on the laws of physics. Situation changes when we introduce the quantum effects. It turns out that for an effective simulation of a quantum system, it is convenient to use another, more controllable quantum system. Implementation of the computation using the qubits and quantum parallelism then in selected cases leads to substantial reduction of complexity. Quantum computers potentially allow realization of computations and simulations, which are practically intractable on classical computer. In particular, there is a direct application on the field of quantum chemistry. This work focuses on simulating many-body problems using quantum computers and analyzes complexity of quantum simulations of atomic nuclei.

Keywords: quantum computer, quantum simulation, many-body physics